PERBADANAN PUTRAJAYA

Putrajaya Stormwater Management
D e s i g n G u i d e l i n e s

ANGKASA GHD ENGINEERS SDN BHD

Putrajaya Stormwater Management Design Guidelines

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PUTRAJAYA STORMWATER MANAGEMENT DESIGN GUIDELINES

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INTRODUCTION

1.1 GENERAL

Putrajaya is being developed as the new Federal Government Administrative Centre for Malaysia. It is located some 26 km south of Kuala Lumpur in the Sungai Chuau catchment as shown in Figure 1.1. The centre is strategically located in the vicinity of the new Kuala Lumpur International Airport and the Multimedia Super Corridor. The centre will consist of government departments, commercial and residential precincts, and recreational parks and the structure plan provides for a population of over 0.5 million people of which 330,000 will live within Putrajaya. As stated by Johan Ariffin and Sahat (1998), the vision for the development of this area is one of a "*dynamic administrative centre, in harmony with nature and its futuristic features*". Central to the development of Putrajaya is the 400 ha Putrajaya Lake, used as a focal point for the Garden City concept proposed. Putrajaya Lake, with a catchment area of 51 km^2 is to provide both passive and active recreational amenities for the Putrajaya community as well as provide wildlife habitats. The water quality of the lake is therefore an important determinant of its ecological health and permissible activities. The proper management of stormwater runoff is considered a vital component in the creation and sustenance of an urban infrastructure in an environment of vibrant ecological elements.

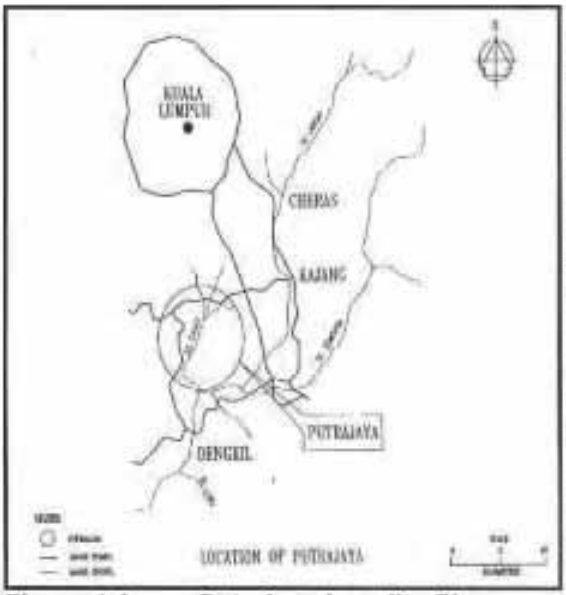


Figure 1.1 Putrajaya Locality Plan

It is widely recognised that urban stormwater runoff are of significantly poorer quality than runoff from a rural catchment. The impact of poor stormwater quality is a growing concern all over the world as urban communities demand better environmental standards in the environment they live in. In greenfield sites, such as the Putrajaya site, there are often significant opportunities to adopt a pro-active and integrated approach to stormwater management. The planning and proper implementation of water sensitive urban design practices for Putrajaya will avoid much of the urban stormwater and receiving water pollution problems associated with many built-up cities. This document was commissioned by Perbadanan Putrajaya to provide guidance on best practice in the management of stormwater generated from the Putrajaya development. In this case, the Putrajaya Lake is the waterbody requiring protection from excessive inputs of stormwater pollutants.

The water quality in the Putrajaya Lake needs to achieve a standard suitable for active, body contact recreational activities. The water quality standard for the Putrajaya Lake is outlined in Chapter 3 of this document. Treatment of stormwater runoff prior to their discharge into the lake is thus essential in achieving and maintaining the water quality standard specified for Putrajaya Lake. An extensive wetland system covering an area of approximately 160 ha is used to provide treatment of stormwater runoff from the 26 km^2 northern and eastern parts of the catchment. The northern part of the catchment draining into the wetlands are largely agricultural areas outside of the Putrajaya boundary and are not part of the proposed development. Runoff from the remaining 20 km^2 catchment area discharge into Putrajaya Lake without treatment or with limited wetland treatment.

All precincts of Putrajaya require some degree of stormwater treatment. In areas discharging into the upper reaches of the wetland system, treatment measures will focus on providing pre-treatment of stormwater entering the wetland system to remove gross pollutants and coarse sediments. For those sub-catchments discharging directly into Putrajaya Lake or into the lower reaches of the wetland system, stormwater treatment will need to provide the full range of stormwater pollution control, from the removal of gross pollutants and coarse sediment to the removal of nutrients and heavy metals.

1.2 PURPOSE

The purpose of this document is to provide guidance on the development and implementation of best practice in stormwater management for the Putrajaya project. The document is not prescriptive as the formulation of an integrated urban stormwater management strategy involves the matching of appropriate structural and non-structural management measures to the site conditions and management objectives (including public safety, drainage economics and water quality standards). **Instead, the purpose of the document is to provide the reader with the necessary information and guidance as tools for the development of stormwater management strategies at the local catchment level as well as at the regional level.** The document is a compilation of current best practices in stormwater management for the protection of the receiving aquatic environment and may be viewed as resource material for formulating stormwater management strategies in general, but with particular reference for application in the Putrajaya project. The document could be used in conjunction with standard hydrologic and hydraulic manuals for urban drainage design.

The document contains 10 chapters including this chapter, with Chapter 2 presenting a broad discussion on the approach to developing stormwater management strategies and Chapter 3 providing guidelines in the form of a checklist for the design of stormwater management measures. The remaining chapters are reference material which the reader needs to be familiar with in order to fully appreciate the technical issues behind the development of stormwater management strategies for the various precincts in the project.

Chapter 4 outlines current practices in the selection of design standards and summarises the design standard applicable for the Putrajaya project. Chapter 5 provides an explanation of the theoretical basis behind hydrological and hydraulic procedures for computing design flows and behaviour of hydraulic structures.

The document then provides the reader with an overview of commonly adopted stormwater quality management measures such as gross pollutant traps (Chapter 6), oil, grease and grit traps (Chapter 7), detention and retention basins (Chapter 8), and constructed ponds and

wetlands (Chapter 9). The overview of these facilities include a discussion on how they function, their design considerations and their appropriate applications. A number of standard designs of gross pollutant traps and a standard oil, grease and grit trap are recommended to facilitate a consistent feature in all precincts of Putrajaya thus allowing for a more efficient maintenance programme. Worked examples are presented to further provide guidance on the design of these facilities. The detailed design of constructed ponds and wetlands require specialist inputs and is outside the scope of this document. The document nevertheless aims to provide the reader with a clear appreciation of the various design elements of constructed ponds and wetlands. Issues covered in Chapter 8 include consideration of the hydrologic and hydrodynamic characteristics of constructed ponds and wetlands, design elements which are directed at achieving the appropriate hydrologic and hydrodynamic behaviour, their influence on the performance of these systems, botanical layout, and the interaction of hydrologic control on sustaining the desired botanical structure of the system.

Often, the most significant export of pollutants, particularly sediment and sediment-bound contaminants, occurs during the construction phase of a project. Chapter 10 of the document discusses best practice in the environmental management of construction activities by presenting the framework leading to the formulation of an environmental management plan a part of the construction plan.

1.3 THE PUTRAJAYA DRAINAGE MASTERPLAN

1.3.1 Overview

Putrajaya is divided into 20 precincts, most of which are directly linked to the Putrajaya Lake or the wetland system. Five of the precincts are located in the Putrajaya Core Area where the landuse encompasses the five principal activities of (i) Government Administration; (ii) Commercial; (iii) Civic and Cultural; (iv) mixed Residential and Commercial; and (iv) Sports and Recreational. The remaining precincts are pre-dominantly residential and mixed residential/recreational precincts. Figure 1.2 shows distribution of proposed landuse and Figure 1.3 shows the location of the various precincts.

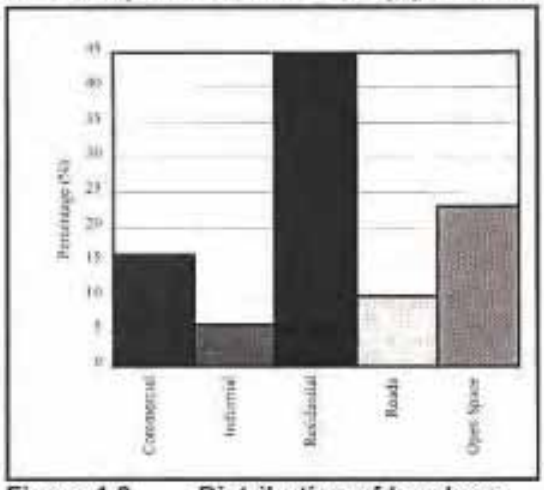


Figure 1.2 Distribution of Landuse in Putrajaya

The Putrajaya Drainage Masterplan, developed by Angkasa-GHD Engineers (1996), sets out the main drainage components of the project based on the design concept of Major Drainage System/Initial Drainage System as outlined in the design procedures for urban drainage by the Department of Irrigation and Drainage of Malaysia. This approach is standard practice in many countries and is often referred to in drainage literature as the Major/Minor drainage approach. The approach reflects an economic risk philosophy to urban drainage by providing the necessary drainage infrastructure (ie. the minor drainage system) for eliminating nuisance flooding in urban areas and ensuring that provision are made (ie. the major drainage system) to manage the flow paths of major flood events to mitigate flood damage in the same area.

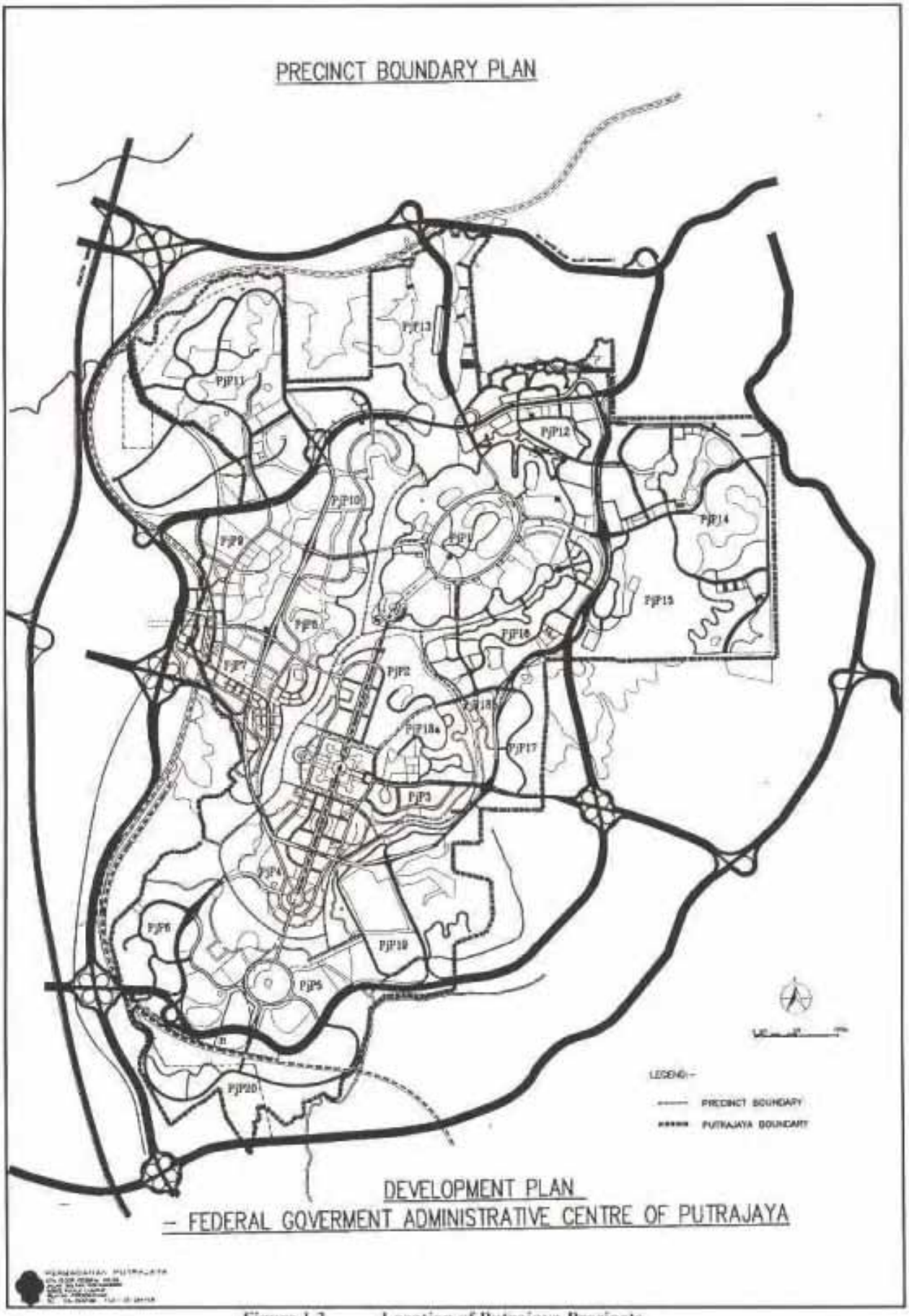


Figure 1.3 Location of Putrajaya Precincts

The masterplan serves to provide a broad strategy for the management of stormwater in Putrajaya. The plan outlines indicative utilisation of stormwater drainage and quality management measures and their appropriate design standards.

The selection of appropriate drainage design standards for the minor and major drainage components of the urban drainage system is dependent on a number of factors (as discussed in Chapter 4) including:-

- inconvenience caused to the public
- consequence of flooding
- safety
- costs of construction and maintenance
- downstream environment impacts.

The proposed drainage design standards for the Putrajaya project is outlined in Section 4.5. Elements of the drainage system listed in the masterplan include stormwater pipes, open channel, culverts and detention basins. The final sizing, location and alignment of the stormwater drainage system for individual precincts can only be confirmed following detailed design by the relevant developer.

Stormwater quality treatment measures suggested in the masterplan included gross pollutant traps and water pollution control ponds. The masterplan provided an overall strategy for the location and sizing of these facilities. These locations are preliminary and it will be necessary for the developer to confirm their appropriate locations and sizes. This will require hydrologic and hydraulic computations specific to the sites in question. Chapter 6 of this document outlines in more detail the design procedure for a number of standard gross pollutant traps applicable for the Putrajaya project while Chapters 8 and 9 outlines procedures for locating and designing retention and detention basins as well as constructed ponds and wetlands.

1.3.2 Drainage Interfacing with the Putrajaya Lake

It is necessary for the stormwater management system to interface with the Putrajaya Lake and wetland system. This simply involves the appropriate design of the stormwater management system to match the operating and 1% AEP (Annual Exceedance Probability) water levels in the receiving waters (ie. at the various wetland cells and the Putrajaya Lake).

Figures 1.4 shows the location of the various cells of waterbody forming the Putrajaya wetland and lake system. Table 1.1 lists the normal operating and 1%AEP water levels in various cells of the wetland system and in the Putrajaya Lake. Figures 1.5, 1.6 and 1.7 show longitudinal sections of the wetland/lake with different operating levels of wetland cells or lake.

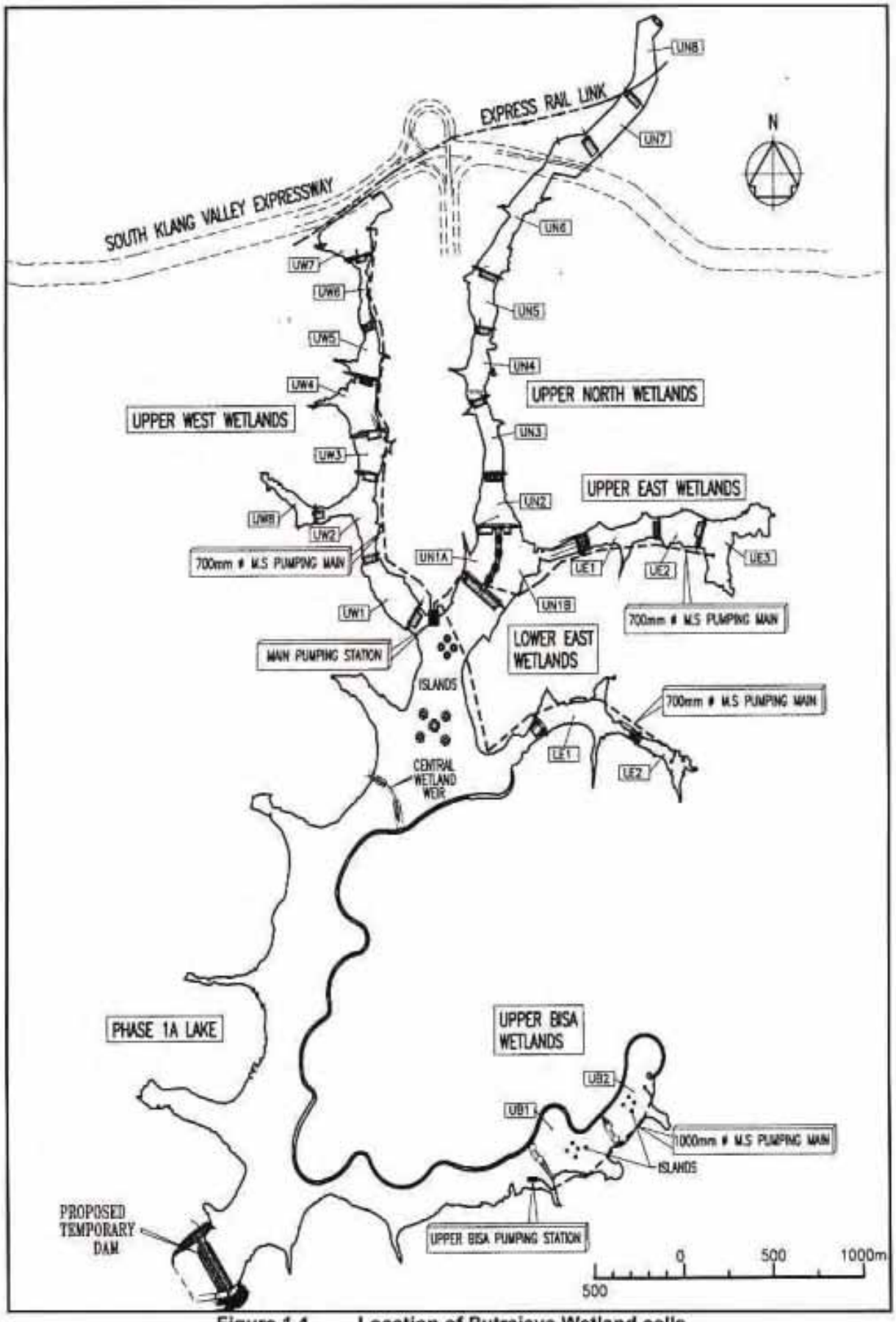


Figure 1.4 Location of Putrajaya Wetland cells

Table 1
Normal Operating and 1% AEP Water Levels

Location	Normal Operating Level	Weir Crest Level	1% AEP Level
Upper North Wetland			
UN 1A	24.50	25.65	26.50
UN 1B	24.50	25.65	26.50
UN 2A	25.00	26.15	27.50
UN 2B	25.00	26.15	27.50
UN 3	26.00	27.15	28.50
UN 4	26.75	27.90	29.50
UN 5	27.50	28.65	30.00
UN 6	29.00	30.65	32.00
UN 7	30.50	31.65	33.00
UN 8	31.00	32.15	33.50
Upper West Wetland			
UW 1	24.50	25.50	26.50
UW 2	25.25	26.25	27.50
UW 3	26.00	27.00	28.00
UW 4	27.00	28.00	29.00
UW 5	27.75	28.75	30.00
UW 6	28.50	29.50	30.50
UW 7	29.00	30.00	31.00
UW 8	28.00	29.00	30.00
Upper East Wetland			
UE 1	28.00	29.50	30.50
UE 2	29.00	30.00	31.00
UE 3	30.00	31.00	32.00
Lower East Wetland			
LE 1	27.00	28.00	29.00
LE 2	30.00	31.00	32.00
Upper Bisa Wetland			
UB 1	24.50	24.50	25.50
UB 2	30.00	30.00	31.00
Central Wetland	23.50	23.50	25.00
Phase 1A Lake (Temporary Dam)	21.00	21.00	22.50
Phase 1B Lake (Main Dam)	21.00	21.00	21.50

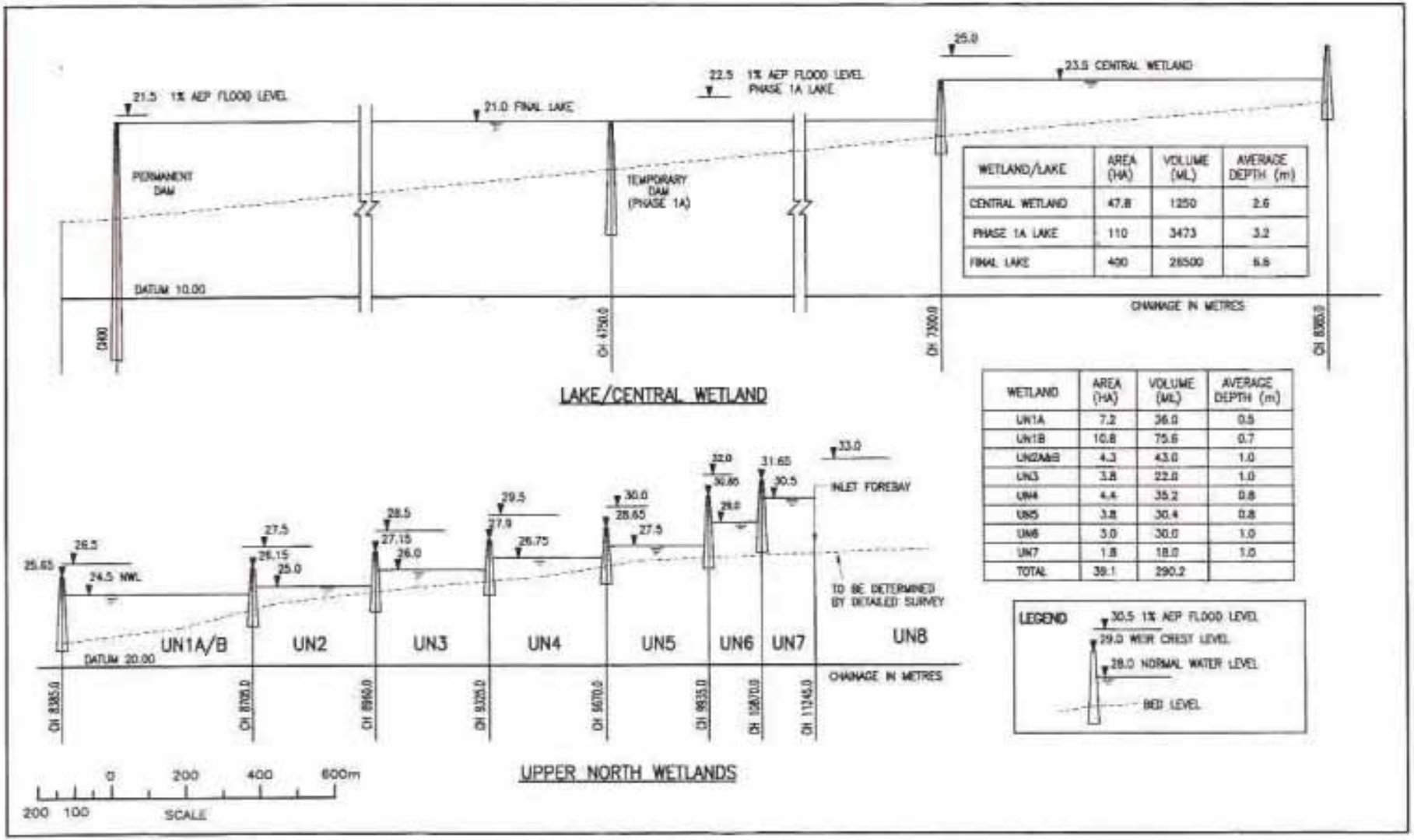
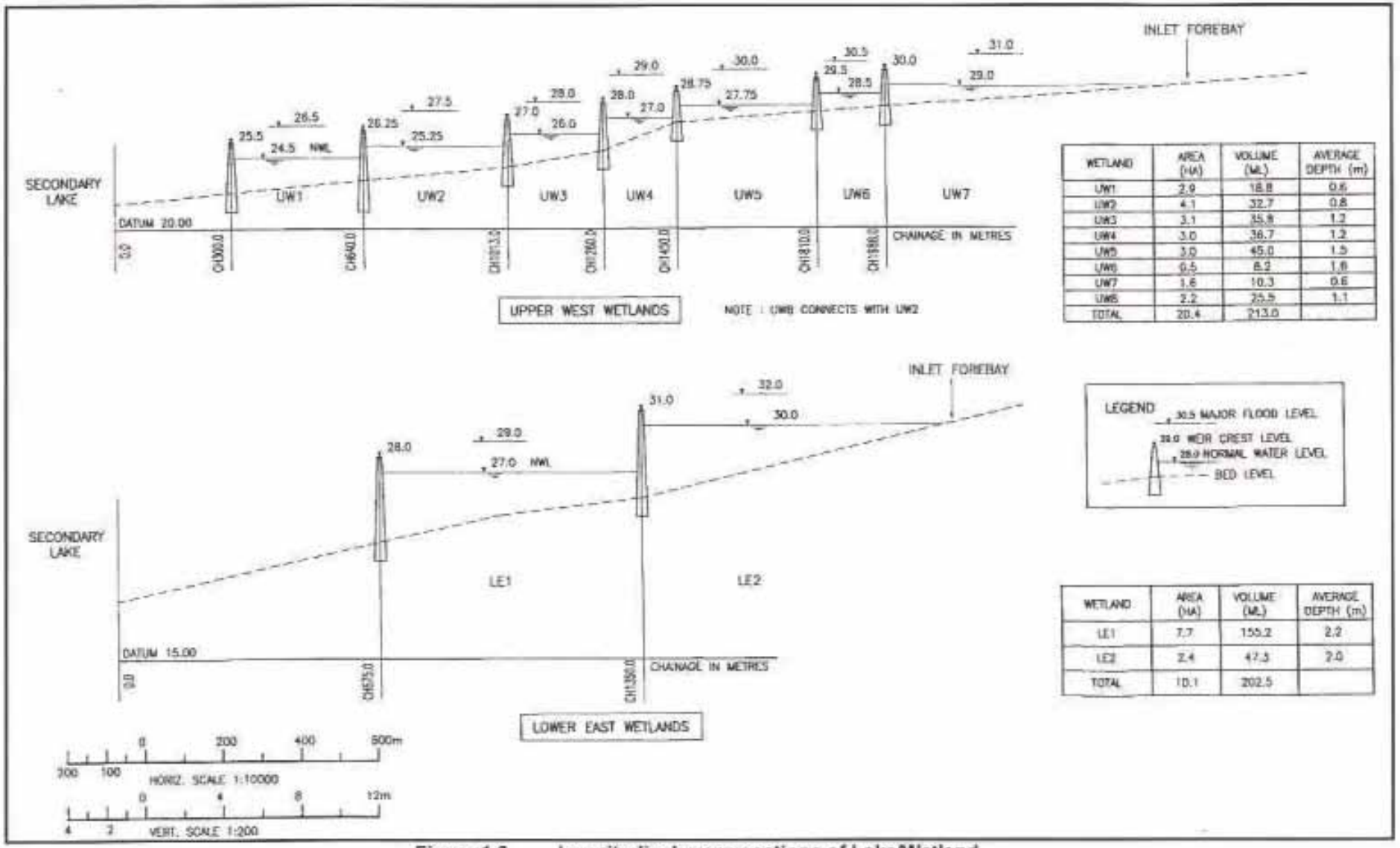


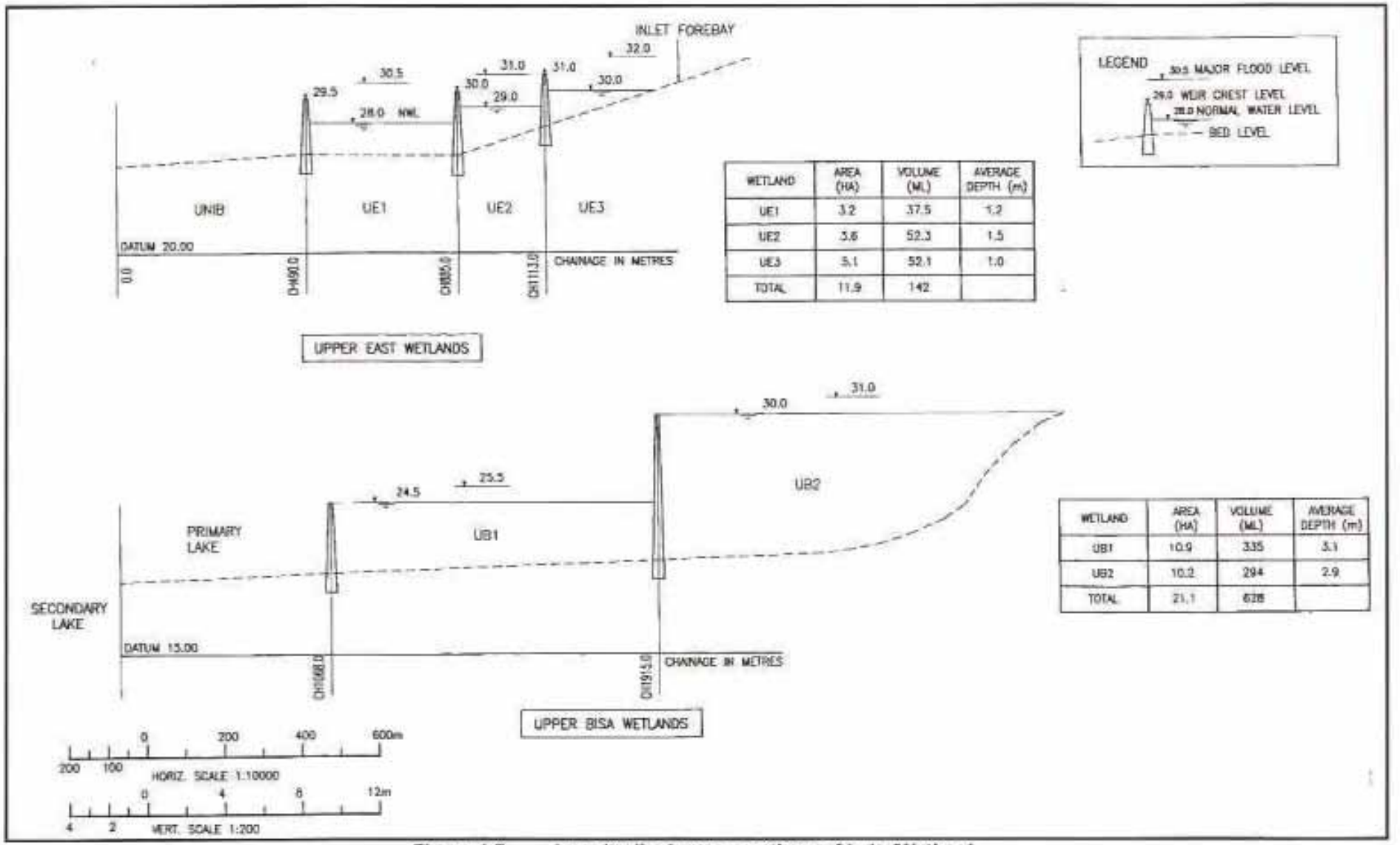
Figure 1.5 Longitudinal cross sections of Lake/Wetland



WETLAND	AREA (HA)	VOLUME (ML)	AVERAGE DEPTH (m)
UW1	2.9	18.8	0.6
UW2	4.1	32.7	0.8
UW3	3.1	35.9	1.2
UW4	3.0	36.7	1.2
UW5	3.0	45.0	1.5
UW6	0.5	8.2	1.6
UW7	1.6	10.3	0.6
UW8	2.2	25.5	1.1
TOTAL	20.4	213.0	

WETLAND	AREA (HA)	VOLUME (ML)	AVERAGE DEPTH (m)
LE1	7.7	155.2	2.2
LE2	2.4	47.3	2.0
TOTAL	10.1	202.5	

Figure 1.6 Longitudinal cross sections of Lake/Wetland



WETLAND	AREA (HA)	VOLUME (ML)	AVERAGE DEPTH (m)
UE1	3.2	37.5	1.2
UE2	3.6	52.3	1.5
UE3	5.1	52.1	1.0
TOTAL	11.9	142	

WETLAND	AREA (HA)	VOLUME (ML)	AVERAGE DEPTH (m)
UB1	10.9	335	3.1
UB2	10.2	294	2.9
TOTAL	21.1	628	

Figure 1.7 Longitudinal cross sections of Lake/Wetland